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REMARKS

Applicant respectfully requests reconsideration and further examination of the present application.

I. Amendments to the Claims

With this Amendment A, claims 1-35 have been canceled, claims 36 and 45 have been amended, claims 46-51 have been canceled, and claims 52-68 have been added. Accordingly, claims 36-45 and 52-68 are now pending.

Claim 36 has been amended to call for a compound having cytoprotective activity wherein substituent R¹ of the formula provided therein is a non-fused polycyclic, hydrophobic substituent which has a bridged or spiro structure. Support for this amendment may be found in original claim 36, as well as in the specification, for example, on: page 6, lines 19-21; page 10, lines 19-23; page 14, line 27 to page 15, line 3; and, page 30, lines 14-34.

Claim 45 has been amended to correct a typographical error and claim dependency. More specifically, claim 45 has been amended to clarify that it is directed to a compound and not a process, consistent with claim 38 from which it depends.

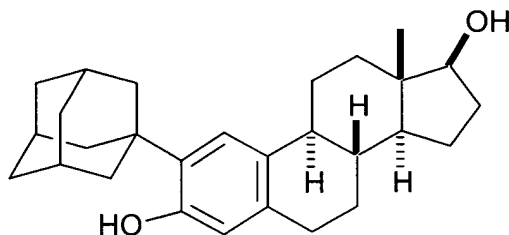
Support for new claims 52-68 may be found in original claim 36, as well as in the specification, for example, on: page 6, lines 19-21; page 10, lines 19-23; page 14, line 27 to page 15, line 3; and, page 30, lines 14-34.

II. Response to Restriction and Election of Species

To confirm Applicant's previous response to the Restriction requirement, Applicant hereby elects to prosecute the claims of Group III (i.e., claims 36-45), and to

cancel without prejudice the claims of Group I (i.e., process claims 1-32, wherein claim 1 is not formula specific), Group II (i.e., claims 33-35), and Group IV (i.e., claims 46-51). Applicant reserves the right to file one or more divisional applications directed to any of the non-elected claims during the pendency of this application.

Furthermore, to confirm Applicant's previous response to the Election of Species requirement, Applicant hereby elects within Group III for initial examination a compound having the formula of claim 43, wherein R_1 is adamantyl (as required by claim 42, from which claim 43 depends), and R^x is H. Accordingly, the elected compound has the formula:



Claims reading on the elected species include at least claims 36, 38 and 41-43, as well as new claims 52-56 and 63-65.

Applicant respectfully submits that, contrary to the Office's assertion in the second sentence on page 5 of the present action, a single disclosed compound has in fact been elected (see above). Accordingly, Applicant further submits that this response is proper. Reconsideration is therefore requested.

III. Rejections under 35 U.S.C. §112, Second Paragraph

Reconsideration is respectfully requested of the rejection of claims 36 and 45 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

As noted above, claim 45 has been amended to correct the typographical error previously present therein. Accordingly, claim 45 is now clearly directed to a compound, which is consistent with claim 38 from which it depends. Reconsideration of this rejection is therefore respectfully requested.

With respect to claim 36, it is to be noted that substituent R¹ is defined as a non-fused polycyclic, hydrophobic substituent having a bridged or spiro structure. It is to be further noted from the specification, on page 30 (lines 14 to 36) for example, that "non-fused, polycyclic," "fused systems," "bridged systems," and "spiro systems" are well-understood terms of art; evidenced of this is the cited Chemical Abstracts publication, a copy of the relevant pages of which is enclosed herewith as Exhibit A.

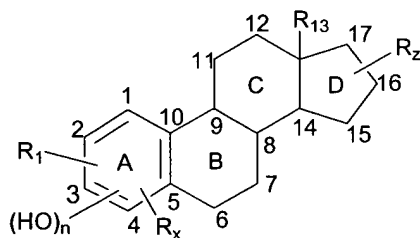
The term "hydrophobic" is a well-understood term of art, as well; evidence of this is enclosed herewith as Exhibit B, which is a copy of the results obtained from a search conducted on January 9, 2004 of the U.S. Patent Office website database of issued U.S. Patents using the phrase "hydrophobic substituent." As can be seen from these search results, numerous U.S. patents have issued which contain the noted phrase in one or more claims therein.

Accordingly, one skilled in the art would understand that claim 36 is directed to a compound wherein substituent R¹ is (i) polycyclic, having a bridged structure or a spiro structure, and (ii) hydrophobic. Applicant therefore respectfully submits that the language of claim 36 is definite, and that it does in fact particularly point out and distinctly claim the subject matter regarded as the invention. Reconsideration of this rejection is therefore respectfully requested.

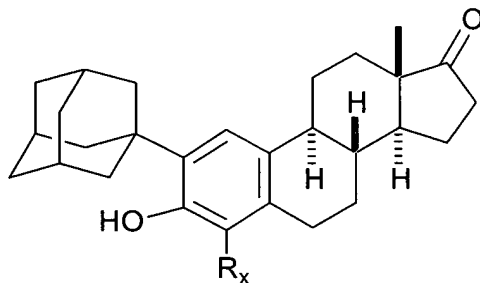
IV. Rejections under 35 U.S.C. §102(b)

Reconsideration is respectfully requested of the rejection of claims 36-45 as being anticipated by Ismail (Eur. J. Med. Chem. (1995)).

As noted above, claim 36, from which claims 37-45 depend, is directed to a compound having cytoprotective activity, the compound having the formula:



wherein: n is 1 or 2; R¹ is a non-fused polycyclic, hydrophobic substituent having a bridged or spiro structure; R^x is selected from the group consisting of hydrogen and substituted or unsubstituted alkyl; R¹³ is hydrogen or substituted or unsubstituted alkyl; and, R² is hydrogen, hydroxy, substituted or unsubstituted alkyl, or oxo, with the proviso that when the compound has the following structure:



R^x is not hydrogen.

Ismail fails to disclose a compound which satisfies each of the requirements of claim 36. Specifically, Ismail does not disclose a compound which has a substituent on the A-ring that is either (i) a hydrophobic, bridged structure (e.g., a hydrophobic, monocyclic structure with valence bonds, atoms or chains connecting different parts of this structure), or (ii) a hydrophobic, spiro structure (e.g., a hydrophobic structure having a pair or pairs of rings having or sharing only one common atom). Rather, as noted compounds 9A and 9B illustrate, Ismail discloses compounds having a ring assembly

substituent on the A-ring (e.g., a substituent which has a pair or pairs of rings connected by single bonds). Thus, Ismail fails to satisfy the requirements of R¹.

In view of the foregoing, claim 36 is submitted as novel over the cited reference. In as much as claims 37-45, as well as new claims 52-57, depend directly or indirectly from claim 36, these claims are submitted as novel over the cited reference for at least the same reason as that noted with respect to claim 36. New claims 58-68 are further submitted as novel over Ismail because this reference clearly fails to disclose an adamantyl substituent, as required therein. Although claims 37-68 include additional novel features, these features will not be addressed at this time in the interests of brevity.

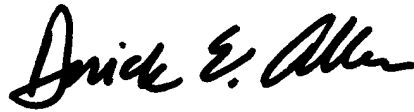
V. The Proviso of Pending Claim 36

In response to the inquiry regarding the proviso of claim 36, Applicant respectfully calls the Examiner's attention to Lunn et al., *The Adamantyl Carbonium Ion as a Dehydrogenating Agent, its Reactions with Estrone*, Tetrahedron Letters, Vol. 24, No. 23 (1968) pp. 6773-6776 (reference no. 37 in the Information Disclosure Statement submitted on February 20, 2002). Applicant respectfully submits that Lunn et al. fail to disclose or suggest the subject matter of the invention as claimed herein.

CONCLUSION

* Applicant encloses herewith a check in the amount of \$55.00 to cover a one (1) month extension of time. The Commissioner is hereby authorized to charge any underpayment or credit any overpayment to Deposit Account No. 19-1345.

Respectfully submitted,



Derick E. Allen, Reg. No. 43,468
SENNIGER, POWERS, LEAVITT & ROEDEL
One Metropolitan Square, 16th Floor
St. Louis, Missouri 63102
(314) 231-5400

DEA/skd
* Enclosures

Naming and Indexing of Chemical Substances for CHEMICAL ABSTRACTS

A reprint of Appendix IV
(Chemical Substance Index Names)
from the CHEMICAL ABSTRACTS
1997 Index Guide



*A publication of CHEMICAL ABSTRACTS SERVICE
Published by the American Chemical Society*

EXHIBIT

A

Naming and Indexing of Chemical Substances for CHEMICAL ABSTRACTS

A publication of CHEMICAL ABSTRACTS SERVICE
Published by the American Chemical Society

A reprint of Appendix IV from *Chemical Abstracts 1997 Index Guide*

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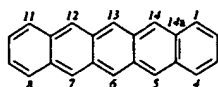
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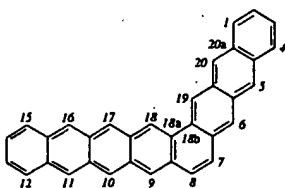
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Systems of five or more ortho-fused benzene rings are named by the "acene" system if the arrangement is linear, by the "phen" system if one central angular site is present.

Examples:



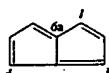
Pentacene



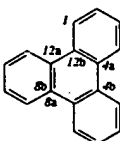
Octaphene

Names ending in "-alene" are employed for bicyclic fused systems, and in "-phenylene" for systems built up from benzene rings fused to alternate sides of a monocyclic hydrocarbon. (Analogous "-naphthylene" names have been used for corresponding 2,3-fusion systems of naphthalene.)

Examples:



Pentalene



Triphenylene

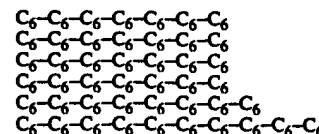
Table IV lists the names of trivially-named fundamental fused carbocycles in ascending order of preference for adoption as base components in the naming of more complex fused hydrocarbon systems. Also included are some of the names discussed immediately above. (The order is based on the rules described in ¶¶138, 150.) The ring analyses describe the number of component rings and the number of atoms each ring contains. Diagrams of these rings, which show the preferred orientation and numbering, are displayed in the *Ring Systems Handbook*. Diagrams justified by current entries are also provided in the semiannual and collective *Chemical Substance Indexes*.

The following ring systems require citation of indicated hydrogen (¶ 135) to complete the name: Indene, Fluorene, Phenalene, Trindene.

TABLE IV
FUNDAMENTAL FUSED CARBOCYCLES IN
ASCENDING ORDER OF PRECEDENCE FOR
USE AS BASE COMPONENTS IN FUSED
SYSTEMS

Name	Ring analysis
Pentalene	C ₅ -C ₅
Indene	C ₆ -C ₆
Naphthalene	C ₆ -C ₆
Azulene	C ₅ -C ₇
Heptalene	C ₇ -C ₇
Biphenylene	C ₄ -C ₆ -C ₆
as-Indacene	C ₅ -C ₅ -C ₆
s-Indacene	C ₅ -C ₅ -C ₆
Acenaphthylene	C ₅ -C ₆ -C ₆
Fluorene	C ₅ -C ₆ -C ₆
Phenalene	C ₅ -C ₆ -C ₆
Phenanthrene	C ₆ -C ₆ -C ₆
Anthracene	C ₆ -C ₆ -C ₆
Trindene	C ₅ -C ₅ -C ₆
Fluoranthene	C ₅ -C ₆ -C ₆ -C ₆
Acephenanthrylene	C ₅ -C ₆ -C ₆ -C ₆
Aceanthrylene	C ₅ -C ₆ -C ₆ -C ₆
Triphenylene	C ₆ -C ₆ -C ₆ -C ₆
Pyrene	C ₆ -C ₆ -C ₆ -C ₆
Chrysene	C ₆ -C ₆ -C ₆ -C ₆
Naphthacene	C ₆ -C ₆ -C ₆ -C ₆
Pleiadene	C ₆ -C ₆ -C ₆ -C ₇
Picene	C ₆ -C ₆ -C ₆ -C ₆ -C ₆
Perylene	C ₆ -C ₆ -C ₆ -C ₆ -C ₆
Pentaphene	C ₆ -C ₆ -C ₆ -C ₆ -C ₆
Pentacene	C ₆ -C ₆ -C ₆ -C ₆ -C ₆
Tetraphenylene	C ₆ -C ₆ -C ₆ -C ₆ -C ₈
Hexaphene	C ₆ -C ₆ -C ₆ -C ₆ -C ₆ -C ₆
Hexacene	C ₆ -C ₆ -C ₆ -C ₆ -C ₆ -C ₆
Rubicene	C ₅ -C ₅ -C ₆ -C ₆ -C ₆ -C ₆ -C ₆

Coronene
Trinaphthylene
Heptaphene
Heptacene
Pyranthrene
Ovalene



149. Fundamental fused heterocycles often have trivial names, e.g., Cinnoline, Xanthene. Others belong to one or another semisystematic system. A linear set of three fused six-membered rings with the same hetero element in both unfused positions of the central ring are given "-anthrene" names.

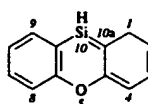
Example:



Boranthrene

A similar set with different hetero elements in these positions is given a "Pheno-" name containing the organic replacement terms in the usual order (Table I, ¶128) and the ending "-in" (or "-ine" if nitrogen, phosphorus or arsenic is included).

Example:



1H-Phenoxasilin

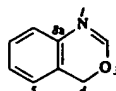
An exception is Phenazine for the analog that contains nitrogen in both central positions.

Arsenic and phosphorus analogs of fused nitrogen heterocycles (Indole, Quinoline, etc.) are named as follows: Arsindole, Isoarsindole, Arsinoline, Isoarsinoline, Phosphindole, Isophosphindole, Phosphinoline, Isophosphinoline, Arsanthridine, Acridarsine, Acridophosphine, Phenarsazine, Phenophosphazine.

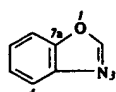
The replacement of the oxygen in Xanthene by sulfur or selenium has been denoted by the appropriate chalcogen functional replacement prefix: Thioxanthene, Selenoxanthene.

In the "benzo" system, bicyclic fused heterocyclic systems containing a benzene ring and a ring named by the Hantzsch-Widman system are indexed by prefixing the latter name by "Benz-" or "Benzo-." Indicated hydrogen, if necessary, and locants are placed in front of the complete name. Similar names are used when benzene is fused to a monocycle with a trivial name (unless the bicyclic system itself has a trivial name).

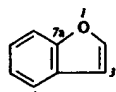
Examples:



4H-3,1-Benzoxazine (not 4H-Benz-[d]oxazine)



Benzoxazole (locants are not cited; the isomers are named 1,2- and 2,1-Benzisoxazole)

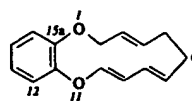


Benzofuran (the isomer is named Isobenzofuran)

Such "benzo" names are not usually adopted as base components of fused systems when only hydrocarbon rings are fused to the benzene portion.

When benzene is fused to a heterocyclic ring containing more than ten skeletal atoms, "Benzo-" or "Benz-" is placed ahead of the replacement ("a") name of the saturated ring and the ending changed to "-in" (or "-ine" if nitrogenous) to indicate the maximum number of noncumulative double bonds. (Saturated positions other than those occupied by indicated hydrogen are denoted by hydro substituents.)

Example:



2H-1,11-Benzodioxacyclotridecin, 5,6-dihydro-

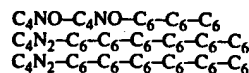
Trivially named fundamental fused hetero systems are listed in Table V. Also included are some of the systems discussed immediately above, as well as a selection of monocyclic hetero systems to help illustrate the ascending order of priority for adoption as base components in complex fused systems.

Fused systems containing only silicon and carbon skeletal atoms are indexed at "Sil-" replacement names if the corresponding hydrocarbon has a fundamental name (Table IV, §148).

TABLE V
FUNDAMENTAL HETEROCYCLES IN
ASCENDING ORDER OF PRECEDENCE FOR
USE AS BASE COMPONENTS IN FUSED
SYSTEMS¹

Index Name	Ring Analysis
Isoarsindole ²	C ₄ As-C ₆
Arsindole ²	C ₄ As-C ₆
Isoarsinoline	C ₅ As-C ₆
Arsinoline	C ₅ As-C ₆
Arsanthridine	C ₅ As-C ₆ -C ₆
Acridarsine	C ₅ As-C ₆ -C ₆
Arsanthrene	C ₄ As-C ₆ -C ₆
Isophosphindole ²	C ₄ P-C ₆
Phosphindole ²	C ₄ P-C ₆
Isophosphinoline	C ₅ P-C ₆
Phosphinoline	C ₅ P-C ₆
Tellurophene	C ₄ Te
Selenophene	C ₄ Se
Selenanthrene	C ₄ Se ₂ -C ₆ -C ₆
Thiophene	C ₄ S
Thianthrene	C ₄ S ₂ -C ₆ -C ₆
Furan	C ₄ O
Pyran ²	C ₅ O
Isobenzofuran	C ₄ O-C ₆
Xanthene ²	C ₅ O-C ₆ -C ₆
Phenoxantimonin	C ₄ OSb-C ₆ -C ₆
Phenoxarsine ²	C ₄ AsO-C ₆ -C ₆
Phenoxaphosphine ²	C ₄ OP-C ₆ -C ₆
Phenoxatellurin	C ₄ OTe-C ₆ -C ₆
Phenoxaselenin	C ₄ OSe-C ₆ -C ₆
Phenoxathiin	C ₄ OS-C ₆ -C ₆
Pyrrole ²	C ₄ N
Imidazole ²	C ₂ N ₂
Pyrazole ²	C ₃ N ₂
Isothiazole	C ₃ NS
Isoxazole	C ₃ NO
Pyridine	C ₅ N
Pyrazine	C ₄ N ₂
Pyridazine	C ₄ N ₂
Pyrrolizine ²	C ₄ N-C ₆ N
Indolizine	C ₄ N-C ₆ N
Indole ²	C ₄ N-C ₆
Indazole ²	C ₃ N ₂ -C ₆
Purine ²	C ₃ N ₂ -C ₄ N ₂
Isoquinoline	C ₅ N-C ₆
Quinoline	C ₅ N-C ₆
Quinolizine	C ₅ N-C ₆ N
Phthalazine	C ₄ N ₂ -C ₆
Naphthyridine ⁴	C ₄ N ₂ -C ₆
Quinoxaline	C ₄ N ₂ -C ₆
Quinazoline	C ₄ N ₂ -C ₆
Cinnoline	C ₄ N ₂ -C ₆
Pteridine	C ₄ N ₂ -C ₄ N ₂
Carbazole ²	C ₄ N-C ₆ -C ₆
Phenanthridine	C ₅ N-C ₆ -C ₆
Acridine	C ₅ N-C ₆ -C ₆
Perimidine ²	C ₄ N ₂ -C ₆ -C ₆
Phenanthroline ⁵	C ₅ N-C ₆ -C ₆
Phenazine	C ₄ N ₂ -C ₆ -C ₆
Anthrydine	C ₅ N-C ₆ -C ₆ -C ₆
Phenarsazine	C ₄ AsN-C ₆ -C ₆
Phenophosphazine	C ₄ NP-C ₆ -C ₆
Phenotellurazine ²	C ₄ NTe-C ₆ -C ₆
Phenoselenazine ²	C ₄ NSe-C ₆ -C ₆
Phenothiazine ²	C ₄ NS-C ₆ -C ₆
Phenoxazine ²	C ₄ NO-C ₆ -C ₆
Thebenidine	C ₅ N-C ₆ -C ₆ -C ₆
Quindoline ²	C ₄ N-C ₆ -C ₆ -C ₆
Quinindoline ²	C ₄ N-C ₆ -C ₆ -C ₆
Phthaloperine ²	C ₅ -C ₄ N ₂ -C ₆ -C ₆ -C ₆
Acridindole ²	C ₄ N-C ₆ -C ₆ -C ₆
Triphenodithiazine	C ₄ NS-C ₄ NS-C ₆ -C ₆ -C ₆

Triphenodioxazine
Phenanthrazine
Anthrazine



¹The order of precedence is based first on the presence or absence of nitrogen, then upon the nature of the (other) hetero atoms (see Table I, §128). For fused heterocycles, this order (for base-component selection) is distinct from that used to determine seniority of a total ring system in an index name (§138).

²Citation of indicated hydrogen (§135), e.g., 1H-Pyrrole, 2H-Pyrrole, is necessary when these component names are used alone.

³Because of established usage, Quinolizine is favored over Isoquinoline and Quinoline as a base component.

⁴Naphthyridine requires the locants 1,5-, 1,6-, 1,7-, 1,8-, 2,6- or 2,7- to define the position of the nitrogen atoms.

⁵Phenanthroline requires the locants 1,7-, 1,8-, 1,9-, 1,10-, 2,7-, 2,8- or 2,9- to define the positions of the nitrogen atoms.

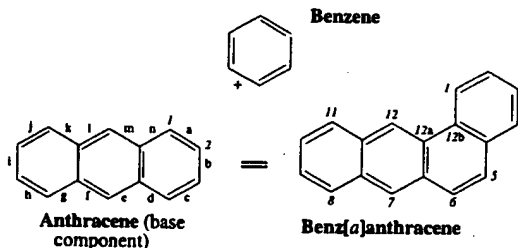
150. Selection of a base component is facilitated by use of Tables IV, §148 and V, §149; the appropriate component listed *latest* in these Tables is used. The system must contain at least two rings of five or more atoms, although such rings need not be directly fused to one another; i.e., they may be joined by a smaller ring, as in Cyclobutadicyclopentene. The criteria for base components differ markedly (in the case of heterocyclic systems) from those described (§138) for a preferred ring system in a compound containing more than one. A base component of lower preference is used if the fusion procedure is not possible on the preferred component; as a last resource, an organic replacement ("a") name based on the fused hydrocarbon is employed.

The preferred base component should:

- be a heterocycle;
- be a nitrogenous heterocycle;
- be a nonnitrogenous heterocycle containing a hetero atom of highest precedence (see Table I, §128);
- contain the greatest number of rings;
- contain the largest individual ring; Benzindene (not Cyclopentanaphthalene) is an exception based on established usage;
- contain the greatest total number of hetero atoms;
- contain the greatest variety of hetero atoms, e.g., one nitrogen and one oxygen rather than two nitrogens;
- contain the greatest number of hetero atoms of highest precedence;
- possess the most linear structure;
- have the lowest locants for hetero atoms (before fusion).

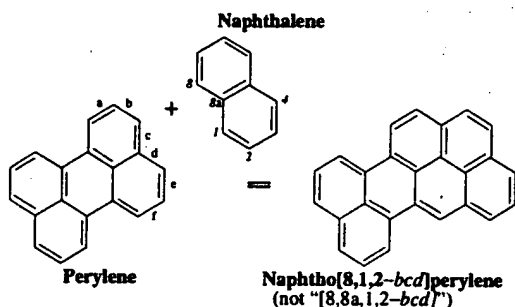
151. Index names for fused systems, other than fundamental systems which possess their own names (Tables IV, §148 and V, §149), are formulated from the names of the components. Cycloalkanes may be adopted as base components by invariant use of the "-ene" suffix. This denotes a maximum number of noncumulative double bonds; e.g., Cyclooctene as part of a fused system is not meant to imply the presence of a single double bond; instead, saturated carbon atoms are indicated by "hydro" prefixes. Fusion locants for the base component comprise lower case italic letters assigned sequentially to all sides, beginning with the side "1,2" as denoted by the usual peripheral locants. (See the *Ring Systems Handbook* for a complete set of ring system diagrams, including base components, complete with such locants.) If more than twenty-six letters are required, subsequent alphabets of the form *a*₁, *b*₁, *c*₁, . . . etc., are adopted. Locants for the fusion prefixes (derived from the less preferred fundamental ring systems) comprise the normal peripheral numerical locants. When a choice is possible, lowest alphabetic and numerical locants are cited. When one or both types of locants are unnecessary they are usually omitted. Numerical and letter locants are separated by a hyphen, and the locant set is bracketed.

Example:



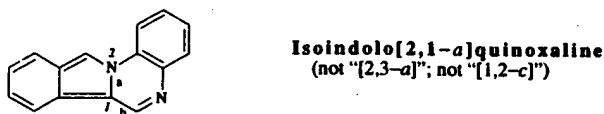
In this example, a locant defining the fusion site on Benzene is unnecessary. The "1,2" side of Anthracene is lettered "a" and the lettering proceeds around every side back to the 1-position. The fused system is then oriented (§152) and renumbered.

Angular positions of base components involved in fusion are not cited.
Example:



When a hetero atom is shared by two or more rings, it is expressed in all the components. When the order of lettering of the base component proceeds in the direction opposite to numbering in the fusion-prefix component, numerical locants for the latter are reversed.

Example:



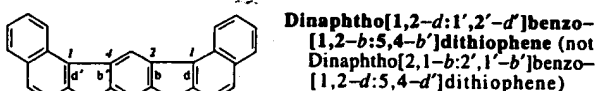
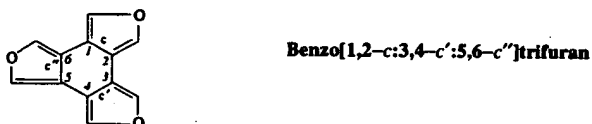
Fusion prefixes are placed in alphabetical order and the earliest cited prefix is given preference for lowest letter locant. When two or more fusion prefixes are identical, as in "Dibenzo-" systems, the letter locants are separated by commas, e.g., "[*a,j*]."

Example:



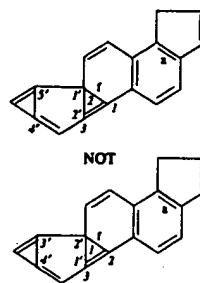
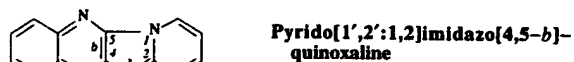
A form of multiplicative name is employed for fused systems different from that described for general substitutive nomenclature. Multiplication proceeds in steps, with "di," "tri" repeated as necessary (not "bis," "tris," etc., except to avoid ambiguity). Serially primed letters are used for fusion sites on the second, third, etc., base components and the locant sets are separated by colons. When a base component is fused to a central component and to another component, lowest letters (when a choice must be made) relate to the central fusion site.

Examples:

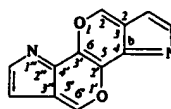
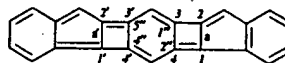


Ring systems fused to base components are designated primary components; a ring system (other than a base component) fused only to a primary component is a secondary component, and primed numerical locants are used to denote its fusion sites. Primed and unprimed locant sets are separated by colons. Lowest locants are used for the site closest to (or fused directly to) the base component. Doubly primed locants are needed (a) when the secondary component is centrally located with identical primary and base components on both sides, and (b) when tertiary components are present.

Examples:



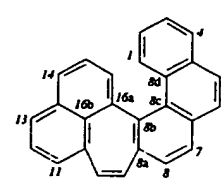
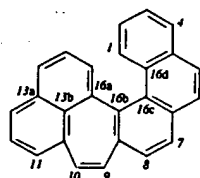
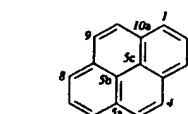
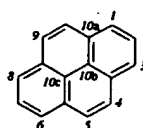
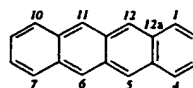
Cyclopenta[*a*]cyclopropa[4,5']-cyclopenta[1',2':2,3]cyclopropa-[1,2-*f*]naphthalene (not Cyclopenta[*a*]cyclopropa[3',4']-cyclopenta[2',1':1,3]cyclopropa-[2,1-*f*]naphthalene.) (The locants 1,2 in the preferred name are lower than 2,1 in the incorrect name. It should be noted that the use of 1',2' requires that the cyclopentane ring be numbered the long way around.)



152. Orientation and numbering of fused systems.

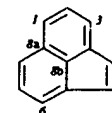
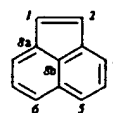
(a) **Hydrocarbons.** The component rings are normally drawn as regular polygons. The cyclopropane ring may point left or right, and cyclopentane and cycloheptane rings may point up or down. The total system is oriented so that (a) a maximum number of rings are in a horizontal row, and (b) a maximum number are above and to the right. If further choice is necessary, then (c) a minimum number of rings should be in the lower left quadrant. Numbering begins at an atom not engaged in fusion in the most counterclockwise position of the uppermost ring furthest to the right. Angular positions are not counted; their locants, when needed, are derived from those of the preceding nonangular positions by addition of the lower-case Roman letters, "a," "b," etc. Interior atoms are numbered last by addition of letters to the highest available numerical locant in a continuous pathway, a clockwise route being followed whenever a choice presents itself; any remaining interior atoms are then numbered similarly from the next highest available numerical locant.

Examples:



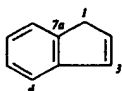
When a further choice is needed for orientation and numbering, carbon atoms at angular positions are assigned lowest numbers.

Examples:



Indicated hydrogen is assigned the lowest locant.

Example:

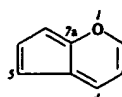


1H-Indene (not 3H-Indene)

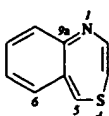
The following fused carbocyclic compounds have special numbering systems: Anthracene, Phenanthrene, Cyclopenta[a]phenanthrene (steroid numbering) and the Cyclopropacyclopenta[a]phenanthrenes.

(b) *Heterocycles*. The ring systems are oriented as for hydrocarbons. When a choice is necessary, lowest locants are assigned to (a) all hetero atoms; (b) most preferred hetero atom (Table I, § 128); (c) carbon atoms common to two or more rings; (d) positions bearing indicated hydrogen; (e) an angular rather than a nonangular atom of the same hetero element. The ring is then numbered as for hydrocarbons, except that hetero atoms common to two or more rings are counted. Interior atoms are numbered last, following the shortest path from the highest previous number.

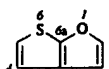
Examples:



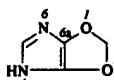
Cyclopenta[b]pyran



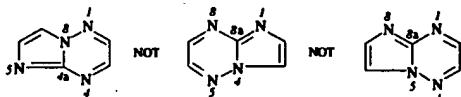
4,1-Benzothiazepine



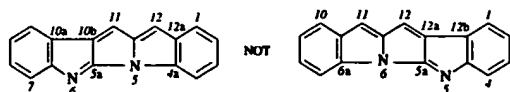
Thieno[2,3-b]furan



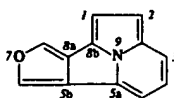
4H-1,3-Dioxolo[4,5-d]imidazole



Imidazo[1,2-b][1,2,4]triazine



Pyrrolo[1,2-a:5,4-b']diindole

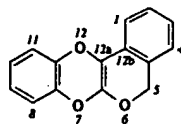


Furo[3,4-a]pyrrolo[2,1,5-cd]-indolizine

The following heterocyclic systems have special numbering systems: Acridine, Carbazole, Purine, Xanthene, and Epoxy- and Epithiocyclopenta[a]phenanthrenes (steroid numbering).

Indicated hydrogen for fused carbocyclic and heterocyclic systems is normally cited, if there is a choice, at the lowest nonangular position, unless a saturated angular atom is required to accommodate a principal function or free valency (see § 135). Indicated hydrogen of component systems is ignored in constructing a fused ring name, and is reassigned if it is still needed in the final system.

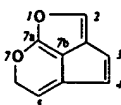
Example:



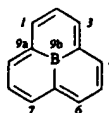
5H-[2]Benzopyrano[3,4-b][1,4]-benzodioxin (Note: The locants "2" and "1,4," which relate to the components, are bracketed to indicate that they do not conform to the peripheral numbering of the total system)

153. Replacement ("a") nomenclature for fused systems is employed when fusion names fail to express all interfaces (fusion sites) between component systems. This occurs when two or more components that are expressed as prefixes are fused to one another as well as to the base component. "A" names are also used for silicon replacement in a carbocycle that has a trivial name. Indicated hydrogen of the parent carbocycle is ignored, but is cited, if needed for the "a" name, ahead of the replacement prefixes.

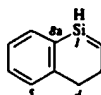
Examples:



6H-1,7-Dioxacyclo[cd]indene (not 1,7-Dioxo-6H-cyclopenta[cd]-indene)



9b-Boraphenylene



1-Silanaphthalene, 3,4-dihydro-

Saturation of double bonds in fused systems is denoted by hydro prefixes which are given lowest locants; e.g., Naphthalene, 1,2,3,4(not 5,6,7,8)-tetrahydro-. Triple bonds are indicated by "didehydro-".

154. Bridged fused systems are fused ring systems that possess atomic bridges or valence bonds which connect two or more parts of the system without creating or extending a fused system. They are named by adding bridge prefixes (in alphabetical order if different types are present) to the fused system names.

Simple bivalent bridges include methano ($-\text{CH}_2-$), ethano ($-\text{CH}_2\text{CH}_2-$), etheno ($-\text{CH}=\text{CH}-$), propano ($-\text{CH}_2\text{CH}_2\text{CH}_2-$), 2-butenio ($-\text{CH}_2\text{CH}=\text{CHCH}_2-$), and benzeno ($-\text{C}_6\text{H}_4-$). Trivalent bridges, e.g., metheno ($-\text{CH}=\text{}$), 1-propanyl-3-ylidene ($-\text{CH}_2\text{CH}_2\text{CH}=\text{}$), and tetravalent bridges are also employed; locants for positions of attachment on the fused system are cited in the same order as free-valency locants of the radicals. Bridges from monocyclic hydrocarbons other than benzene are named as for the fusion prefixes, except that "endo-" is used with them to avoid ambiguity, e.g., "endo-cyclopenta-". Simple hetero bridges include epoxy ($-\text{O}-$), epithio ($-\text{S}-$), imino ($-\text{NH}-$), epidioxy ($-\text{O}-\text{O}-$), and -silano- ($-\text{SiH}_2-$). Heterocyclic rings may also be used as bridges.

Example:



3,4-furano (cf. "furo" for the fusion prefix)

When locants are used for the bridge itself, e.g., 2-butenio, 3,4-furano-, they are placed in brackets within the bridged system name.

Compound bridges are named by combination of simple bridges beginning at the terminal position which gives the preferred (a) cyclic bridge (§ 138), (b) hetero atom (Table I, § 128), (c) chain, (d) alphabetic order.

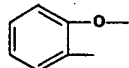
Examples:



(iminoethano)



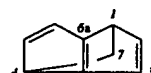
(epoxythioxy)



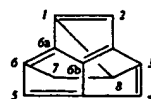
(epoxy[1,2]benzeno)

Indicated hydrogen of a fused system is cited, if possible, to accommodate a bridge. When this is unnecessary or impossible, the lowest-numbered nonangular indicated hydrogen is cited for the fused system, and additional indicated hydrogen, when needed, is cited ahead of the bridge locants.

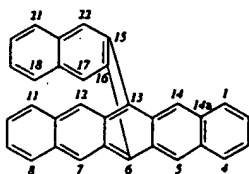
Examples:



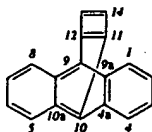
1,4-Methanopentalene, 1,4-dihydro-



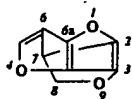
6,1,3-Ethanylylidene-cyclopenta[cd]pentene



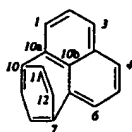
6,13[2',3']-Naphthalenopentacene



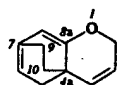
9,10[1',2']-endo-Cyclobutananthracene



3,2,6-(Epoxyethanylylidene)furo-[3,2-b]furan

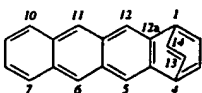


7,10-Ethenocyclohepta[de]-naphthalene

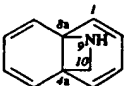
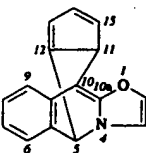
5H-4a,7-Ethano-2H-1-benzopyran
(4aH-1-Benzopyran cannot exist)

Numbering of bridged fused systems is based on the regular numbering of the parent fused system. Lowest locants are assigned to bridgehead positions and the bridge atoms are numbered from the end nearest the highest numbered position of the parent fused system. In cyclic bridges, e.g., benzeno, *endo*-cyclobuta, the shorter bridge is first numbered, and then the rest of the ring in the same direction. If possible, hetero atoms in bridges are numbered low.

Examples:

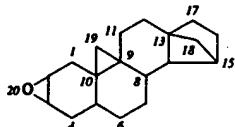


1,4-Ethenonaphthalene

8a,4a-(Iminomethano)naphthalene
(not 4a,8a-(Iminomethano)-naphthalene)

11H-5,10[1',2']-endo-Cyclopent-5H-oxazolo[3,2-b]isoquinoline

The exceptional numbering employed for bridged cyclopenta[a]-phenanthrenes is shown in the following example. Steroid numbering is used for positions 1 through 17. When the methyl groups normally numbered 18 and 19 are transformed into methano bridges, their locants are retained. Other bridges are numbered 20 and upward.



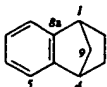
Criteria for the naming of bridged fused systems are applied successively as follows:

(a) The unbridged system contains the maximum number of (i) rings, (ii) skeletal atoms.

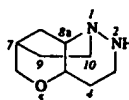
(b) The bridges are as simple as possible; e.g., two simple bridges are preferred to one compound bridge, and saturated bridges are preferred to unsaturated ones.

(c) The unbridged system has the highest precedence according to ¶ 138(c).

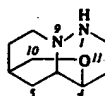
Examples:



1,4-Methanonaphthalene, 1,2,3,4-tetrahydro- (not 1,3-Ethano-1H-indene, 2,3-dihydro-)



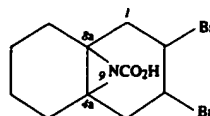
NOT



1,7-Ethano-1H-pyrano[3,2-c]-pyridazine, octahydro- (not 4,6-(Epoxyethano)-1H-pyrido[1,2-b]pyridazine, octahydro-)(The fused ring system Pyranopyridazine is preferred to Pyridopyridazine; see ¶ 138.)

Fused carbocyclic and nonnitrogenous heterocyclic systems with simple imino bridges are named by use of the termination "-imine" with appropriate locants. Such a name requires addition of a regular functional suffix when appropriate. (Nitrogen heterocycles with imine bridges are named as bridged fused heterocycles in the usual manner.)

Example:



Naphthalen-4a,8a-imine-9-carboxylic acid, 2,3-dibromo-octahydro-

155. Von Baeyer nomenclature. This was first developed to name alicyclic hydrocarbons containing two rings. It has been extended to all bridged systems which cannot be treated as fused or bridged fused systems. Von Baeyer names for hydrocarbons are formed by prefixing to the name of the acyclic hydrocarbon with the same number of carbon atoms "Bicyclo-", "Tricyclo-", etc., terms, followed by a set of numerals, separated by periods and bracketed, which describes in descending sequence the number of atoms in each bridge. The system is numbered from one bridgehead via the other bridgehead(s) and back, always choosing the longest route. The system is numbered along the same route, ending with the smallest bridge, numbered from the bridgehead with the highest locant.

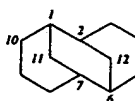
Example:



Bicyclo[4.3.2]undecane

For tricyclo- and higher hydrocarbon systems, superscripts are employed to indicate the positions of secondary bridges.

Example:

Tricyclo[5.3.1.1^{2,6}]dodecane

When more than one Von Baeyer name is possible for a hydrocarbon, the choice is determined by the following principles, applied successively until a decision is reached.

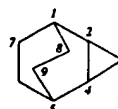
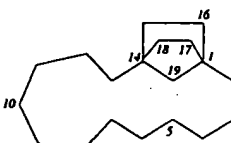
(a) The main ring contains the maximum number of atoms, two of which must serve as bridgeheads for the main bridge.

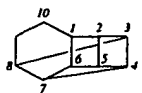
(b) The main bridge is as large as possible.

(c) The main ring is divided as symmetrically as possible by the main bridge.

(d) Lowest superscripts (regardless of order of citation) are cited.

Examples:

Tricyclo[3.2.2.0^{2,4}]nonane (not Tricyclo[2.2.2.1^{2,3}]nonane)Tricyclo[3.2.1.0^{2,7}]octane (not Tricyclo[2.2.2.0^{2,6}]octane)Tricyclo[12.2.2.1^{1,14}]nonadecaneTricyclo[4.4.1.1^{1,5}]dodecane
(not Tricyclo[5.3.1.1^{1,6}]dodecane)



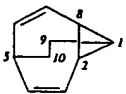
Pentacyclo[4.4.0.0^{2,5}.0^{3,8}.0^{4,7}]decane
(not Pentacyclo[4.4.0.0^{4,9}.0^{5,8}.0^{7,10}]decane; not Pentacyclo[4.4.0.0^{2,5}.0^{3,10}.0^{4,9}]decane; not Pentacyclo[4.4.0.0^{2,9}.0^{3,8}.0^{7,10}]decane)

Unsaturation is denoted by “-ene” and “-yne” suffixes. A second locant in parentheses is cited for a double bond at a bridgehead when it does not proceed to the next atom in the numbered path. Multiple-bond locants are determined by the following criteria applied successively:

- The numbering proceeds in a clockwise sequence.
- The cases in which both locants for a double bond are cited are minimized.

(c) Lowest locants are employed.

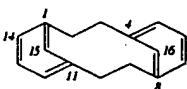
Examples:



Tricyclo[3.3.2.0^{2,8}]deca-3,6-diene



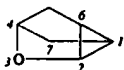
Bicyclo[4.2.0]oct-6-ene (not Bicyclo[4.2.0]oct-1(8)-ene)



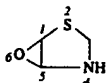
Tricyclo[9.3.1.1^{4,8}]hexadeca-1-(15),4,6,8(16),11,13-hexaene (not Tricyclo[9.3.1.1^{4,8}]hexadeca-4,6,8-(16),11(15),12,14-hexaene)

Von Bayer names for *heterocyclic systems* are formed from the hydrocarbon names by use of replacement (oxa, thia, aza, etc.) prefixes and lowest locants for hetero atoms in the order of Table I, ¶ 128. Unsaturation is denoted as for hydrocarbons.

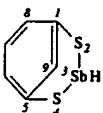
Examples:



3-Oxatricyclo[2.2.1.0^{2,6}]heptane (not 5-Oxatricyclo[2.2.1.0^{2,6}]heptane; (not 2-Oxatricyclo[2.2.1.0^{3,5}]heptane) (low numbering for bridge takes precedence over hetero atom)



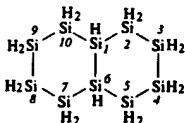
6-Oxa-2-thia-4-azabicyclo[3.1.0]hexane (not 6-Oxa-4-thia-2-azabicyclo[3.1.0]hexane)



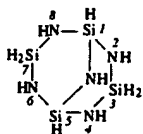
2,4-Dithia-3-stibabicyclo[3.3.1]nona-1(9),5,7-triene (not 2,4-Dithia-3-stibabicyclo[3.3.1]nona-1(8),5(9),6-triene)

Saturated bridged systems containing only silicon atoms, or silicon atoms alternating with nitrogen or one of the chalcogens, are given Bicyclosilazane, Tricyclosiloxane, etc., names. Regular Von Bayer numbering is employed.

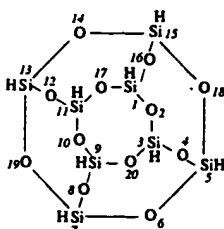
Examples:



Bicyclo[4.4.0]decasilane



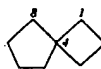
Bicyclo[3.3.1]tetrasilazane



Pentacyclo[9.5.1.1^{3,9}.1^{5,15}.1^{7,13}]octasiloxane

156. Spiro systems contain pairs of rings or ring systems having only one atom (a “spiro atom”) in common. In the simplest monospiro systems, in which two alicyclic rings share an atom, the name is formed by prefixing to the acyclic hydrocarbon name the term “Spiro” and numerals (separated by periods) in *ascending* sequence to define the number of atoms in each ring linked to the spiro atom. The numbering begins at the atom *next* to the spiro atom in the smaller ring and proceeds around that ring, through the spiro atom and around the larger ring.

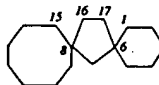
Example:



Spiro[3.4]octane

This system is extended to dispiro and higher systems. Numbering begins next to a terminal spiro atom and proceeds in such a way as to give the spiro atoms lowest locants.

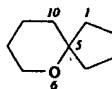
Example:



Dispiro[5.1.7.2]heptadecane (note that the numbering path corresponds to the bracketed sequence)

Heterocyclic analogs are named by “a” nomenclature. The hetero atoms are given locants as low as are compatible with the ring numbering.

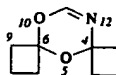
Example:



6-Oxaspiro[4.5]decane

Unsaturation is expressed by “-ene” and “-yne” suffixes.

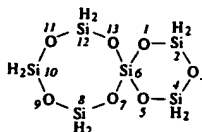
Example:



5,10-Dioxo-12-azadispiro[3.1.3.3]dodec-11-ene

Saturated spiro systems containing only silicon atoms or silicon atoms alternating with nitrogen or one of the chalcogens are given Spirosilazane, Spirosiloxane, etc., names.

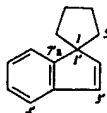
Example:



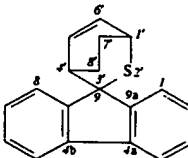
Spiro[5.7]hexasiloxane

Monospiro systems containing at least one fused or bridged component are named by placing the component names in brackets in alphabetical order and prefacing them with “Spiro.” The position of the spiro atom is denoted by two locants, separated by a comma, related to the two components. Primes are used for the component cited second. Indicated hydrogen (¶ 135) is assigned, where possible, to accommodate the spiro unions. Locants related to the components but not to the total spiro system are bracketed to avoid ambiguity.

Example:



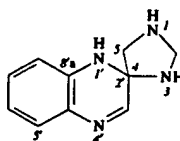
Spiro[cyclopentane-1,1'-(1H)-indene] (not Spiro[cyclopentane-1,1'-1'H-indene])



Spiro[9H-fluorene-9,3'-(2)thiabicyclo[2.2.2]oct[5]ene]

Added hydrogen (¶ 136) is cited in parentheses in the usual way, but with a primed locant if it does not relate to the component cited first. It is assigned the lowest available locant unless a different one can be used to accommodate a principal group.

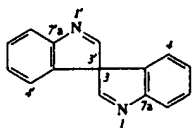
Example:



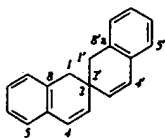
Spiro[imidazolidine-4,2'(1'H)-quinoxaline]

Monospiro systems containing identical fused components are given "Spirobi-" names. The component name is bracketed if it is preceded by locants or is itself made up of fusion components. Added hydrogen is cited in parentheses following the spiro locants.

Examples:



3,3'-Spirobi[3H-indole]

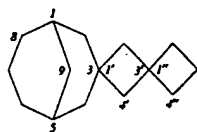


2,2'(1H,1'H)-Spirobinaphthalene

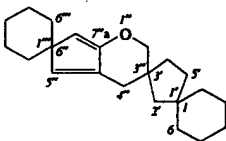
Di-, tri-, etc., spiro systems containing at least one fused or bridged component are named by extension of these policies. If terminal components are identical, citation is determined by earliest index position of the complete name. Serially primed locants are used for successive components.

"Branched" polyspiro systems in which a single component is surrounded by three or more identical components are named by citing the central component (which is assigned plain locants) first and multiplying the identical (terminal) components. When two terminal components of a "branched" spiro system are identical, and one different, they are cited in alphabetical order (as usual) and the term "bis" is applied as appropriate.

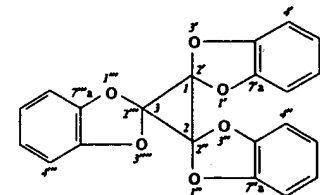
Examples:



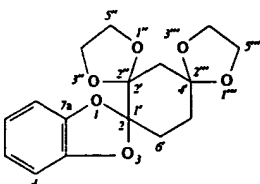
Dispiro[bicyclo[3.3.1]nonane-3,1'-cyclobutane-3',1''-cyclobutane]



Trispiro[cyclohexane-1,1'-cyclopentane-3',3''(2''H)-cyclopentab[pyran-6''(4''H),1'''-cyclohexane]



Trispiro[cyclopropane-1,2':2,2'':3,2''-tris[1,3]benzodioxole]

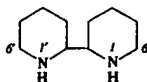


Trispiro[1,3-benzodioxole-2,1'-cyclohexane-2',2'':4,2'''-bis[1,3]dioxolane]

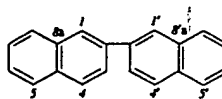
157. Ring assemblies contain a multiplicity of the same cyclic system joined by single bonds, not necessarily in equivalent positions. They are treated as molecular skeletons in substitutive nomenclature and rank just above the component ring. Except for assemblies of benzene, and two-component assemblies of cycloalkanes, cycloalkenes, and hetero systems with "cyclo" names (see below), they are named by prefixing the component names with the terms Bi-, Ter-, Quater-, Quinque-, Sexi-, Septi-, Octi-, Novi-, Deci-, Undeci-, etc.

Locants are placed ahead of the name to define the points of attachment. These locants are as low as possible, compatible with fixed numbering (expressed or implied) of the components, including "-ene" and "-yne" suffixes.

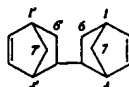
Examples:



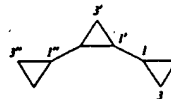
2,2'-Bipiperidine



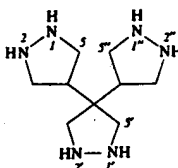
2,2'-Binaphthalene



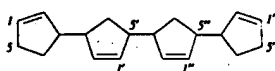
5,5'-Bibicyclo[2.2.1]hept-2-ene (not 2,2'-Bibicyclo[2.2.1]hept-5-ene)



1,1':2',1''-Tercyclopropane



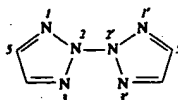
4,4':4'',4'''-Terpyrazolidine



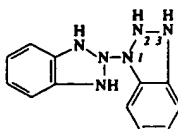
3,3':5',3'':5'',3'''-Quatercyclopentene

Indicated hydrogen (§135) is assigned, where possible, to points of attachment. When indicated hydrogen is cited in different positions for different components, a ring-assembly name is not used. Added hydrogen (§135) is cited immediately after the locant to which it relates.

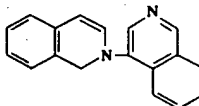
Example:



2,2'-Bi-2H-1,2,3-triazole



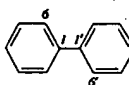
1H-Benzotriazole, 1-(1,3-dihydro-2H-benzotriazol-2-yl)-2,3-dihydro- (not 1H-Benzotriazole, 2-(2,3-dihydro-1H-benzotriazol-1-yl)-2,3-dihydro-; not 1(3H),2'-Bi-2H-benzotriazole, 1',3'-dihydro-)



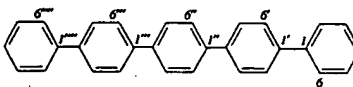
2(1H),4'-Biisoquinoline

Linear benzene assemblies (*polyphenyls*) are named by prefixing "phenyl" with the appropriate term (Bi-, Ter-, etc.). Arabic numeral locants are cited in all cases for points of attachment. Two-component assemblies of monocyclic hydrocarbons and of hetero systems with "cyclo" names, e.g., Cyclopentastannane, Cyclotrisiloxane, and monocycles with one silicon using "sila" names, are named from the *radicals*, and locants for the points of attachment are cited only when the radical has no locant for the free valency. Two-component ring-assembly names from unsaturated ("enyl") radicals are formed only when the unsaturation is symmetrical with respect to the points of attachment.

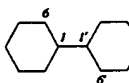
Examples:



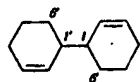
1,1'-Biphenyl



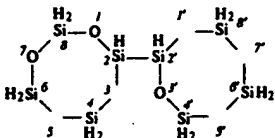
1,1':4',1'':4'',1''':4''',1''''-Quinquephenyl



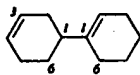
1,1'-Bicyclohexyl (not Bicyclohex-1-yl)



Bi-2-cyclohexen-1-yl (not 1,1'-Bi-2-cyclohexen-1-yl)



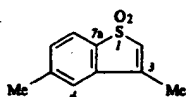
Bicyclotetrasiloxan-2-yl



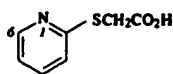
Cyclohexene, 1-(3-cyclohexen-1-yl)- (not Cyclohexene, 4-(1-cyclohexen-1-yl)- (lowest locant for the substituent prefix is preferred (¶ 138)))

158. Neutral hetero atoms with abnormal valencies in ring systems are expressed (a) by additive terms, e.g., "oxide," "sulfide," in the modification; (b) by the greek letter "λ" followed by a superscript numeric (c) by the prefix "hydro" (in molecular skeletons not treated normally in substitutive nomenclature); (d) by superscript Roman numerals attached to the italicized element symbol, e.g. S^{IV}; (e) by substituent prefixes, e.g. "oxido"; (f) by a combination of methods a, b, c, d or e above.

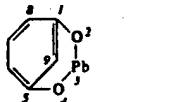
Examples:



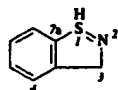
Benzo[b]thiophene, 3,5-dimethyl-1,1-dioxide



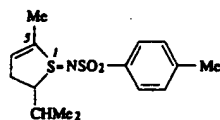
Acetic acid [(1-oxido-2-pyridinyl)thio]- (former modification *N*-oxide)



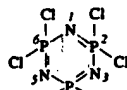
2,4-Dioxo-3λ²-plumbabicyclo-[3.3.1]nona-1(9),5,7-triene



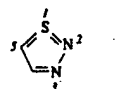
3H-1λ⁴-1,2-Benzisothiazole



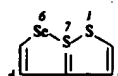
Thiophene, 1,1,2,3-tetrahydro-5-methyl-2-(1-methylethyl)-1-[[[(4-methylphenyl)sulfonyl]imino]- (because the abnormal valency cannot be expressed in a substituent by an approved method, the higher (sulfonamide) function is "overstepped")



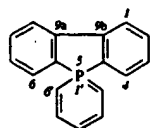
1,3,5,2,4,6-Triazatriphosphorine, 2,2,4,4,6,6-hexachloro-2,2,4,4,6,6-hexahydro-



1,2,3-Thia(S^{IV})diazole



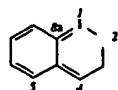
7λ⁴-[1,2]Dithiolo[5,1-c][1,2]thiaselenole



Spiro[5H-dibenzophosphole-5,1'λ³-phosphorin]

In a few cases, abnormal valency is implied rather than expressed, e.g. cyclic iodine systems, in which iodine is usually trivalent.

Example:



3H-1,2-Benziodoxin

159. Boron molecular skeletons. Because the number of hydrogen atoms in neutral and anionic boron hydrides often bears no simple relationship to the number of boron atoms, borane names must express the number of both. (The single exception is Borane itself, which represents BH₃.) The *Ring Systems Handbook* should be consulted for structural diagrams of the neutral polyboranes of established structure. Diagrams justified by current index entries are displayed in the *Chemical Substance Indexes*. (In these diagrams, the lines do not represent electron-pair bonds but indicate the geometry of the structures.) Neutral boron hydrides, real or hypothetical, are treated as molecular skeletons in substitutive nomenclature. Borane and the diboranes as heteroacyclic compounds, the higher hydrides as heterocyclic compounds. Borane(1) is BH, Borane(2) is BH₂. In higher boranes, the number of boron atoms is expressed by multiplicative prefixes.

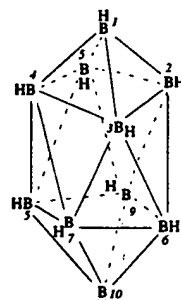
Examples:

B ₂ H ₄	Diborane(4)
B ₂ H ₆	Diborane(6)
B ₃ H ₇	Triborane(7)
B ₄ H ₁₀	Tetraborane(10)
B ₅ H ₉	Pentaborane(9)
B ₆ H ₁₀	Hexaborane(10)
B ₁₀ H ₁₄	Decaborane(14)

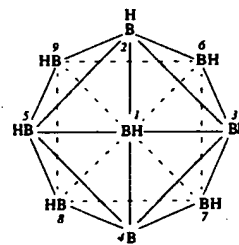
Until structures have been determined, author terms such as "*iso*" and "*neo*" are cited in index modifications to differentiate isomers.

Numbering of polyboranes in CA indexing is based on "Nomenclature of Boron Compounds" adopted by the American Chemical Society, and "Nomenclature of Inorganic Boron Compounds", published by the International Union of Pure and Applied Chemistry,¹ which may be consulted for further details. For "closed" polyboranes (those whose boron skeletons are polyhedra with triangular faces throughout) the numbering begins with the boron atom at the head of the largest axis of highest order, then proceeds sequentially to the planes which intersect this axis. Boron atoms in each plane are numbered clockwise unless lowest locants for substituents demand anticlockwise numbering. On succeeding planes, numbering begins at the boron atom immediately "below" the lowest-numbered one on the previous plane, or the one nearest to it in the direction of numbering.

Example:



Decaborane(10)

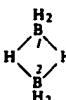


planar projection

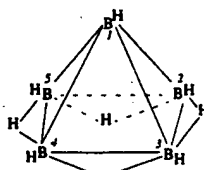
(Note that atom "6" (in the lower plane) is nearest to atom "2" in the direction of numbering.)

For "open" polyboranes (those with incomplete polyhedral boron skeletons) the rules are more complex. A planar projection, as viewed from the open side, is numbered so that interior boron atoms have lowest locants, beginning at the "center" or "apex." Each atom set is numbered in the same direction.

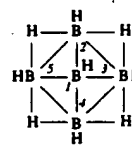
Examples:



Diborane(6)

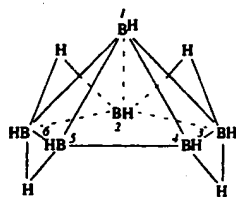


Pentaborane(9)

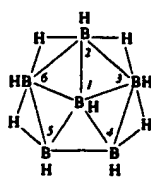


planar projection

¹Inorg. Chem. 1968, 7(10), 1945-65; Pure Appl. Chem. 1972, 30(3-4), 683-710.



Hexaborane(10)



planar projection

Some polyboranes can be named as derivatives of simpler polyboranes. Thus, a bimolecular polyborane, i.e., a two-component "ring" assembly in which both skeletons are identical, can be named as follows:

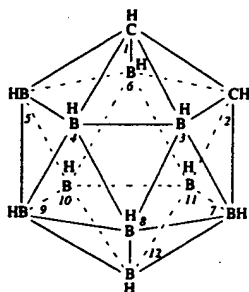
1,1'-Bipentaborane(9)

When the various parts of the structure are not identical, the general principles of substitutive nomenclature are applied, and a polyborane radical is used for the less preferred skeleton, e.g., Decaborane(10), 2-octaboran(8)-1-yl.

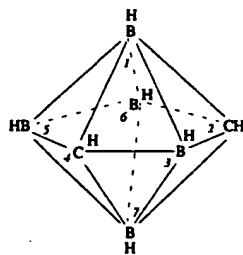
Polyboranes joined along an edge, or with a triangular face in common, are named like fused ring systems; e.g., Decaborano(14)[5',6':5,6]decaborane(14), Undecaborano(2',7',11':1,2,3)dodecaborane(17).

160. "Hetero" polyboranes are boron hydride skeletons in which boron atoms have been replaced by those of other elements, notably carbon. Replacement prefixes, e.g., "carba," "phospha," are employed with the polyborane name, and the number of hydrogen atoms attached to the skeleton expressed in parentheses after the name. Structural diagrams for compounds of established structure can be found in the *Ring Systems Handbook* and, when justified by current entries, in the *Chemical Substance Index*. Numbering is as for the parent polyboranes, with lowest compatible locants assigned to the replacement atoms.

Examples:



1,2-Dicarbadoecaborane(12)



2,4-Dicarbaheptaborane(7)

161. Substituent prefixes (radicals) derived from molecular skeletons are used very frequently in substitutive nomenclature. Their names are based on the skeleton names and may be classified accordingly as radicals from (a) monoatomic skeletons, (b) hydrocarbon chains, (c) organic hetero ("a"-named) chains, (d) homogeneous hetero chains, (e) heterogeneous hetero chains, (f) carbocycles, (g) heterocycles, (h) ring assemblies, (i) polyboranes. Combination of simple radicals to form compound and complex radicals is performed by application of principles described earlier (§ 133). (See also "Illustrative List of Substituent Prefixes," which constitutes Section H (§ 294).)

(a) Monoatomic radicals from borane, methane, silane, germane, stannane, and plumbane are named by replacing "-ane" by "-yl," "-ylene," and "-ylidene" to denote the loss of one, two, or three hydrogen atoms. The final "e" of the hydrides arsorane and phosphorane may be replaced by "-yl," "-ylidene," and "-ylidene." Stibine and bismuthine may have the "-ine" ending replaced by "-ino," "-ylene," and "-ylidene." Phosphine and arsine may have the "-ine" replaced by "-ino," "-inidene," and "-inidene." The -tetrayl suffixes indicate loss of all hydrogen from Group IVA monoatomic hydrides

Examples:

H ₂ B-	boryl	HC≡	methylidyne
H ₂ C=	methylene	HSi≡	silylidyne

-Sn-	stannanetetrayl	HA≡	arsinidene
H ₂ P-	phosphino	As≡	arsinidyne
HP≡	phosphinidene	H ₂ Sb-	stibino
P≡	phosphinidyne	HSb≡	stibylene
H ₄ P-	phosphoranyl	Sb≡	stibylidyne
H ₃ P≡	phosphoranylidene	H ₂ Bi-	bismuthino
H ₂ P≡	phosphoranylidyne	HBi≡	bismuthylene
H ₂ As-	arsino	Bi≡	bismuthylidyne

(b) Acyclic hydrocarbon radicals are named from the skeletons by replacing "-ane," "-ene," and "-yne" suffixes by "-yl," "-enyl," and "-ynyl," (for monovalent radicals); by "-diyl," "-triyl," "-enediyl," "-ynediyl," etc., for divalent radicals with hydrogen removed at more than one position; and by "-ylidene" and "-ylidene" to indicate two or three atoms lost at one position. (Methylene is an exception.) Locants are not cited for monovalent radicals (the free valency position is always "1"), but unsaturated positions are always indicated for chains of three or more atoms. Free valencies (single or multiple) in one or two positions of an acyclic chain are always terminal, otherwise a compound radical name is employed. When three or more positions have free valencies, two of them must be terminal.

Examples:

MeCH ₂ -	ethyl
H ₂ C=CHCH ₂ -	2-propenyl (not allyl)
EtCH=	propylidene
PrC≡	butylidyne
H ₂ C=C=	ethenylidene
H ₂ C=CHCH=	2-propenylidene
MeC≡CCH ₂ CH=CHCH=	2-hepten-5-ynylidene
-(CH ₂) ₂ -	1,2-ethanediyl
-CH ₂ CH=	1-ethanyl-2-ylidene
-CH=CH-	1,2-ethenediyl
-(CH ₂) ₃ -	1,3-propanediyl
=C=C=C=	1,2-propadiene-1,3-diylidene
-CH ₂ CHCH ₂ -	1,2,3-propanetriyl
-CH ₂ CCH ₂ -	1,3-propanediyl-2-ylidene

(c) Organic heteroacyclic ("a") radicals are used when the requirements (§ 127) are met. The numbering of the parent radical (not necessarily that of the molecular skeleton) is retained. A single free valency is hence always in the 1-position, and this locant is always cited. When there is still a choice, lowest locants are assigned to hetero atoms, then to most preferred hetero atoms (Table I, § 128), then to unsaturation (with double bonds preferred).

Examples:

Me[(OCH ₂) ₂]OCH ₂ CH ₂ -	3,6,9,12-tetraoxatridec-1-yl (not [2-[2-[2-(2-methoxyethoxy)-ethoxy]ethoxy]ethyl])
MeSiH ₂ CH ₂ SiH ₂ CH=CHSiH ₂ CH ₂ SiH ₂ CH=	2,4,7,9-tetrasiladec-5-en-1-ylidene
-CH ₂ CH ₂ [S(CH ₂) ₂] ₂ SCH=CHNHCH ₂ CH ₂ -	3,6,9-trithia-12-azatetradec-10-ene-1,14-diyl

(d) Homogeneous heteroacyclic radicals are named analogously to acyclic hydrocarbon radicals, except that only the "e" of "ane" suffixes of heteroacyclic skeleton names is replaced by "-yl."

Examples:

NN=N-	diazanyl (the substituted radical is named azo)
H ₂ NNHNH-	triazanyl
NN=NNH-	2-triazenyl

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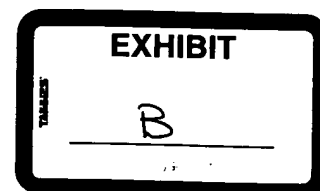
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